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An Effective Shrinkage Threshold for Contourlet based on Image Denoising in Natural Images

Jannath Firthouse P[1], Latha Rani G.L[2], Shajun Nisha S[3]

M.Phil. (PG Scholar) Dept of Computer Science, Sadakathullah Appa College, India[1, 2]

Prof& Head, P.G Dept of Computer Science, Sadakathullah Appa College, India [3]

Abstract: Image Denoising is an underlying problem in the field of image processing. In moreover, the intension of image denoising is to eliminate the noises as well as to conserve the details of an image as much as possible. Noise is a haphazard variation of image intensities and its shows as grains in the image. In this work Gaussian and Salt & Pepper noise are added to the input image. Contourlet is used for decomposition and the main advantage of Contourlet transform is to preserve the edges and contours. After decomposition, thresholding function are used such as Sure Shrink and Visu Shrink. These Shrinkage methods is to remove the noises effectively. After the noise removal, Performance of the denoised images is analysed and find the better threshold. Performance of natural image denoising is deliberate by Peak Signal to Noise Ratio (PSNR), Image Quality Index (IQI), Normalized Cross Correlation(NCC).

Keywords: Image Denoising, Contourlet, Shrinkages, PSNR.

I. INTRODUCTION

Digital images plays an notable task in daily life application such as Natural images, Magnetic Resonance Image(MRI), Computed Tomography(CT), Satellite Television, and astronomy etc. Image denoising is a fundamental step in the image processing. Image Denoising is to confiscate the unnecessary noises at the same time it preserves the main characteristic of the information and its enhance the image clarity also. Noise can corrupted by different intrinsic and extrinsic conditions. In practical situation its not possible to avoid a noises. Noises may be additive and Multiplicative. Additive noises are always interrupted with natural images. Additive noises are Gaussian and Salt & Pepper. Contourlet Transform is based on Laplacian Pyramid and Directional Filter bank. It forms the Multiresolution directions and its gives the output image with the smooth regions. Contourlet is a Multidimensional and Multiscale representation method. Thresholding is the best one to condense the noises in the image. Additive random noises are easily removed by threshold methods. Many Thresholding function are in the image processing such as Bayes, Neigh, Sure, Neigh Sure, Bivariate, Visu and Normal Shrink etc.

A. Related Works

Image Denoising is one of the rudimentary step in digital image processing and its plays an ineluctable task in image processing and computer vision application. Denoising affects the image quality with some artifacts. [1]. Its main aim is to recover the best estimate of the original image from its noisy versions[13]. Image noise is the random variation of brightness or color information in images produced by the sensor and circuitry of a scanner or digital camera. Image noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector [8]. A noise can be categorized depending on its source, frequency spectrum and time characteristics. Depending on a source, the noises are categorized into : acoustic noise; thermal and shot noise; electromagnetic noise; electrostatic noise; channel distortions, echo and fading; processing noise [16]. The contourlet transform is applied for the noisy image to produce decomposed image coefficients. Basically Contourlet transform is a double filter bank structure. It consists of a Laplacian pyramidal filter followed by a directional filter bank. First the Laplacian pyramid (LP) is used to capture the point discontinuities. Then directional filter bank (DFB) used to link point discontinuities into linear structures. Similar to wavelet, contourlet decomposes the image into different scales. Unlike the wavelet contourlet decomposes each scale into arbitrarily power of two’s number of directions [2]. The threshold method, developed by Donoho [17] in 1995, provides a viable treatment option for the wavelet coefficients of nonlinear processing and, consequently, significantly advanced the field of image denoising. Objective quality measures are based on a mathematical comparison of the original and processed or enhanced image and can give an immediate estimate of the Perceptual quality of an image enhancement algorithm[10][12].

B. Motivation and Jusitification

Noise Reduction is an important aspect in image processing. Image Denoising is used to improve and preserve the fine details that may be hidden in the data. In Image processing, noise is not easily eliminated as well as preserving edges is also difficult. Contourlet is the greatest method for preserving the edges. Images are decomposed with any degree of directionality this is one of the big advantage in Contourlet Domain. Contourlet can clearly represent the lines, edges, curves etc. It can work well in both natural images and medical images for identifying the

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geometrical structures. Contourlet is better than Wavelet because it has retained the accurate information. During these advantages I modivate and justified to do work in Contourlet Domain.

C. Organization of the work

The paper is planned as follows. Methodology which includes the outline of the work of the Contourlet Domain. Thresholding techniques are presented in Setion II. Experimental results are shown in Section III. Performance Evaluation is also discussed in Section IV. Lastly Conclusion is presented in Section V.

II. METHODOLOGY

A. Outline of the work

Denoising algorithm uses Contourlet Transform. This system is articulated in Fig 1.Gaussian and Salt & Pepper nosie is added with the three input images such as Boat, House, Flower. Contourlet Transform is used to decompose the noisy image and then apply the threshold function to the noisy image to get the denoised output image.

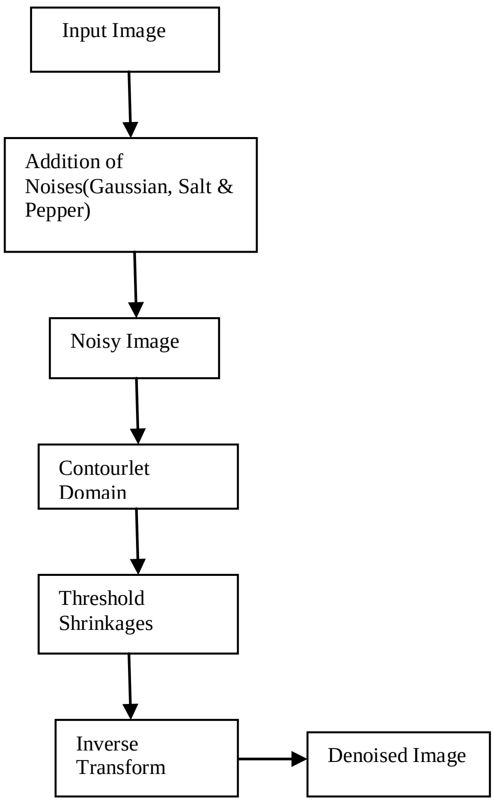

Fig 1 Block Diagram for Contourlet with Threshold

B. Contourlet Transform

The Contourlet Transform (CT) is a directional multiresolution image representation scheme proposed by Do and Vetterli, which is effective in representing smooth contours in different directions of an image, thus providing directionality and anisotropy [14]. The method utilizes a double filter bank (Figure 1) in which, first the Laplacian Pyramid (LP) [22] detects the point discontinuities of the image and then the Directional Filter Bank (DFB) [19] links point discontinuities into linear structures. The LP provides the means to obtain multiscale decomposition. In each decomposition level it creates a downsampled lowpass version of the original image and a more detailed image with the supplementary high frequencies containing the point discontinuities. This scheme can be iterated continuously in the lowpass image and is restricted only by the size of the original image due to the downsampling. The DFB is a 2D directional filter bank that can achieve perfect reconstruction. The simplified DFB used for the contourlet transform consists of two stages, leading to 2l subbands with wedge-shaped frequency partitioning [18]. The first stage is a two-channel quincunx filter bank [21] with fan filters that divides the 2D spectrum into vertical and horizontal directions. The second stage is a shearing operator that just reorders the samples. By adding a shearing operator and its inverse before and after a two-channel filter bank, a different directional frequency partition is obtained (diagonal directions), while maintaining the ability to perfectly reconstruct the original image. By combining the LP and the DFB, a double filter bank named Pyramidal Directional Filter Bank (PDFB) is obtained. Bandpass images from the LP decomposition are fed into a DFB in order to capture the directional information. This scheme can be repeated on the coarser image levels, restricted only by the size of the original image. The combined result is the contourlet filter bank. The contourlet coefficients have a similarity with wavelet coefficients since most of them are almost zero and only few of them, located near the edge of the objects, have large magnitudes [11].

C. Thresholding Techniques

Thresholding is a technique used for signal and image de-noising. The shrinkage rule defines how we apply the threshold [23].[6]It is clearly proved that highest PSNR value is achieved at lowest standard deviation and lowest PSNR at highest Standard Deviation.Most of the real time and online applications require these types of filters with less execution time.

1) Visushrink:

Visushrink was introduced by Donoho [Do92]. It uses a threshold value't' that is proportional to the standard deviation of the noise. It follows the hard thresholding rule. It is also referred to as universal threshold and is defined as

$$t-\sigma\sqrt{2\log N} \qquad (1)$$

σ^2 is the noise variance present in the signal and n represents the signal size or number of samples. Visushrink does not deal with minimizing the mean squared error. Visushrink is known to yield recovered images that are overly smoothed. This is because Visushrink removes too many coefficients. Another disadvantage is that it cannot remove speckle noise. It can only deal with an additive noise [4].

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2) Sure Shrink:
Sure Shrink is a thresholding by applying sub band adaptive threshold, a separate threshold is computed for each detail sub band based upon SURE (Stein's unbiased estimator for risk), It is a combination of the universal threshold and the SURE threshold. The sure threshold is define as

$$\lambda = \min\left(t, \sigma\sqrt{2\log(M)}\right) \qquad (2)$$

Where M is number of wavelet coefficients in the particular subbands. t denotes the value that minimizes Stein's Unbiased Risk Estimator. is noise variance. n is the size of the image. SURE shrink has yielded good image denoising performance and comes close to the true minimum MSE of the optimal soft-threshold estimator[7]

D. Noise Models
1) Gaussian Noise or Amplifier Noise:
This noise has a probability density function [pdf] of the normal distribution. It is also known as Gaussian distribution. It is a major part of the read noise of an image sensor that is of the constant level of noise in the dark areas of the image.[5]

$$p(z)=\frac{1}{\sqrt{2\pi\sigma}}e^{\frac{-(z-\mu)^2}{2\sigma^2}} \qquad (3)$$

2) Salt & Pepper Noise:
Pepper and Salt noise are a form of the noise classically seen on the images. Salt and pepper noise represents itself as randomly happening black and white pixels. Pepper and Salt noise creeps into images in circumstances where quick transients, such as defective switching, take place. Salt and pepper noise is random in nature; it distributed randomly in the image pixel values [15].

III. EXPERIMENTAL RESULTS

Experimental results were conducted to denoise a natural images such as Boat. House, Flower are shown in Fig 3. Gaussian and Salt & Pepper noises were considered. Thresholding Techinques are studied and their various denoised images is shown in Fig 4, Fig 5 and Fig6

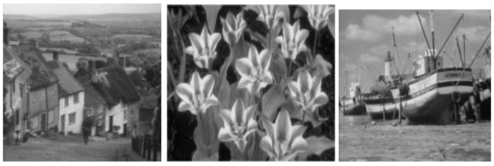


Fig 2 Original Image for House, Flower, Boat

Threshold Type	Gaussian Noise		Salt & Pepper Noise	
	Noisy Image	Denoised Image	Noisy Image	Denoised Image
Visu				
Sure				

Fig 3 Denoised image of Boat

Threshold Type	Gaussian Noise		Salt & Pepper Noise	
	Noisy Image	Denoised Image	Noisy Image	Denoised Image
Visu				
Sure				

Fig 4 Denoised image of House

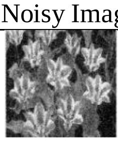
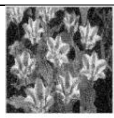
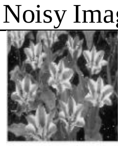
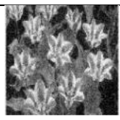
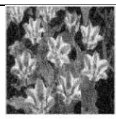
Threshold Type	Gaussian Noise		Salt & Pepper Noise	
	Noisy Image	Denoised Image	Noisy Image	Denoised Image
Visu				
Sure				

Fig 5 Denoised image of Flower

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IV. PERFORMANCE ANALYSIS

A. Performance Parameters

i)Peak Signal to Noise Ratio (PSNR):
It is the ratio between maximum possible power of a signal and the power of corrupting noise that affects the quality and reliability of its representation. PSNR is calculated as

$$PSNR = 10Log_{10}\left(\frac{MAX^2}{MSE}\right) \quad (4)$$

Where MSE is mean square error and MAX is the maximum pixel value of image [8].

ii) Normalized Correlation:
Normalized correlation is calculated by

$$NK = \sum_{I=1}^{M}\sum_{J=1}^{N}(g(i,j).g'(i,j)]/\sum_{i=1}^{M}\sum_{J=1}^{N}(g(i,j))^2 \quad (5)$$

If the normalized cross correlation tends to 1, then the image quality is deemed to be better[3].

iii) Image Quality Index(IQI):
The Image Quality Index (IQI), Q, is proposed by Wang and Bovik [20] as a product of three different factors: loss of correlation, luminance distortion, and contrast distortion and is defined as

$$Q=\frac{\sigma_{fg}}{\sigma_{f}\sigma_{g}}\cdot\frac{2\bar{f}\bar{g}}{\bar{f}^2+\bar{g}^2}\cdot\frac{2\sigma_f\sigma_g}{\sigma_f^2+\sigma_g^2} \quad (6)$$

The first component of eqn. (10) is the correlation coefficient between f and g, which measures the degree of linear correlation between f and g and its dynamic range is [-1,1]. The second component, with a value range of [0,1], measures how close the mean luminance is between f and g. σ_f and σ_g can be viewed as estimate of the contrast of f and g, so the third component with a value range of [0,1] measures how similar the contrasts of the images are.Thus, Q can be rewritten as

$$Q=\frac{4\sigma_{fg}\bar{f}\bar{g}}{(\sigma_f^2+\sigma_g^2)(\bar{f}^2+\bar{g}^2)} \quad (7)$$

B. Performance Evaluation
The performance of Contourlet was evaluated by using PSNR, NCC, IQI. The experiments Visu and Sure Shrink have been tested and their denoised image results are shown in Table I, Table II, and Table III. Considered all the metrics, it is observed that the Visu Shrink performs well for three images such as Boat, Flower and House.

In Table I, II, III analysis it identifies the best threshold for a specific noises. From Table I, its observed that Visu Shrink is well Suitable for both Gaussian and Salt & Pepper noise. In Table II Gauusian noise is better removal for Visu shrink and Salt & Pepper noise is better removal for Sure Shrink.In Table III Gaussian is suited for Sure Shrink and Salt & Pepper is suited for Visu Shrink.

TABLE I CONTOURLET FOR DENOISED BOAT IMAGE

Threshold Type	Metrics	Noises	
		Gaussian	Salt & Pepper
Visu	PSNR	**20.0499**	**25.4776**
	IQI	0.41172	0.76648
	NCC	1.017	0.99915
Sure	PSNR	20.0213	25.2674
	IQI	0.41303	0.76424
	NCC	1.0189	0.99901

TABLE II CONTOURLET FOR DENOISED HOUSE IMAGE

Threshold Type	Metrics	Noises	
		Gaussian	Salt & Pepper
Visu	PSNR	**20.0824**	25.3624
	IQI	0.39783	0.78093
	NCC	1.0162	0.99979
Sure	PSNR	20.0383	**25.4624**
	IQI	0.39661	0.78493
	NCC	1.0183	0.99989

TABLE III CONTOURLET FOR DENOISED FLOWER IMAGE

Threshold Type	Metrics	Noises	
		Gaussian	Salt & Pepper
Visu	PSNR	20.2274	**25.2153**
	IQI	0.59155	0.8677
	NCC	1.0176	0.99879
Sure	PSNR	**20.2281**	25.085
	IQI	0.59179	0.85824
	NCC	1.0184	0.99989

V. CONCLUSION

This paper presents for natural image denoising based on Contourlet Domain. Contourlet is one of the best method for decomposition compared with the wavelet. The images are corrupted with Gaussian and Salt & Pepper noises. Thresholding techniques are Visu and Sure Shrink. After denoising, the image clarity is too enhanced. Quantitative performance measure such as PSNR, NCC, IQI are used to evaluated the denoised image effect. From the result it is observed that Gaussian noise and Salt & Pepper are well suitable for Visu Shrinkages.

REFERENCES

[1] Jannath Firthouse.P ,Shajun Nisha.S ,Dr.M.Mohammed Sathik "Noise Reduction in MRI Images using Contourlet Transform and Threshold Shrinkages Techniques",International Journal of Computer Science and Information Technology (IJCSIT)2016
[2] Sakthivel K.," Contourlet Based Image Denoising Using New-Threshold Function", International Journal of Innovative Research in Computer and Communication Engineering ,March 2014.
[3] S.P.Chokkalingam, K.Komathy, M.Vinoth And R.Saravanan" Performance Analysis Of Bone Images Using Various Edge

Detection Algorithms And Denoising Filters" International Journal of Pharma and Bio Sciences April 5 2014

[4] Mukesh Kumar Mishra, Sameena Zafar, "Performance Analysis of Probshrink Image Denoising Method Based on its PSNR Value", International Journal of Engineering Innovation & Research Volume 3, Issue 1 2014

[5] Priyanka Kamboj1 and Versha Rani*2" A Brief Study Of Various Noise Model And Filtering Techniques " in Journal of Global Research in Computer Science Volume 4, No. 4, April 2013

[6] Rajesh Kumar Rai, Jyoti Asnani, R.R.Sontakke, "Review on Shrinkage Techniques for Image Denoising", International Journal of Computer Applications, Vol. 42, Issue No.19, pp. 13-16, March 2012.

[7] S.Sulochana, R.Vidhya, " Image Denoising using Adaptive Thresholding in Framelet Transform Domain" , International Journal of Advanced Computer Science and Applications, Vol. 3, No. 9, 2012

[8] Cheng Chen; Ningning Zhou, "A new wavelet hard threshold to process image with strong Gaussian Noise", Advanced Computational Intelligence (ICACI), 2012, Page(s): 558 – 561

[9] Olawuyi, N.J." Comparative Analysis of Wavelet Based Denoising Algorithms on Cardiac Magnetic Resonance Images" Afr J Comp & ICT Olawuyi et al - Comparative Analysis of Wavelet-Based Denoising Algorithm Vol 4. No.1. June 2011

[10] Francisco Estrada and Allon Jepson. Stochastic "Image Denoising". ESTRADA, FLEET, JEPSON, 2009.

[11] Yifan, Z. and Liangzheng, X., "Contourlet-based feature extraction on texture images," Proc. International Conference on Computer Science and Software Engineering, 221-224 (2008).

[12] S.Kother Mohideen., Dr. S. Arumuga Perumal. and Dr. M. Mohamed Sathik,"Image Denoising using Discrete Wavelet Transform", IJCSNS International Journal of Computer Science and Network Security. VOL. 8 No.1, January 2008

[13] D.Ghandurai and V.sadasivam,"an effective adaptive thresholding technique for wavelet based image denoising."World academy of science, engg. &technology, 2008.

[14] Do, M. N. and Vetterli, M., "The contourlet transform: an efficient directional multiresolution image representation," IEEE Transactions on Image Processing 14(12), 2091-2106 (2005).

[15] Scott E Umbaugh, Computer Vision and Image Processing, Prentice Hall PTR, New Jersey, 1998

[16] Astola. JandKuosmanen.P, "Fundamentals of Nonlinear Digital Filtering", Boca Raton, FL: CRC, 1997.

[17] D. L. Donoho, "De-noising by soft-thresholding," IEEE Transactions on Information Theory, vol. 41, no. 3, pp. 613–627, 1995.

[18] Shapiro, J. M., "Embedded image coding using zerotrees of wavelet coefficients," IEEE Transactions on Signal Processing 41(12), 3445-3462 (1993).

[19] Bamberger, R. H. and Smith, M. J. T., "A filter bank for the directional decomposition of images: Theory and design," IEEE Transactions on Signal Processing 40(4), 882-893 (1992).

[20] Cohen, A., Daubechies, I. and Feauveau, J. C., "Biorthogonal bases of compactly supported wavelets," Communications on Pure and Applied Mathematics 45(5), 485-560 (1992).

[21] Vetterli, M., "Multidimensional subband coding: Some theory and algorithms," Signal Processing 6(2), 97-112 (1984).

[22] Burt, P. J. and Adelson, E. H., "The Laplacian Pyramid as a compact image code," IEEE Transactions on Communications 31(4), 532-540 (1983).

[23] Byung-Jun Yoon and P. P. Vaidyanathan,"Wavelet-based denoising by customized thresholding", Work supported in part by the ONRgrant N00014-99-1-1002, USA.

BIOGRAPHIES

P. Jannath Firthouse received the B.sc degree in Computer Science from MS University in 2013 and M.sc degree in Computer Science from MS University in 2015.She is currently pursuing the M.Phil degree in Computer Science under the guidance of S. Shajun Nisha. Her Research interest are mainly include domain of Medical Image Denoising

Latha Rani G.L is currently pursuing M.Phil degree in computer science in Sadakathullah Appa College, Tirunelveli. And completed my MCA degree, 2013 in National Engineering College, Kovilpatti graduated under Anna University Chennai. And completed B.Sc (Computer Science) in 2010 in Rosemary College of Arts Of Science graduated under Manonmaniam Sundaranar University, Tirunelveli.

Shajun Nisha S, Professor and Head of the Department of Computer Science, Sadakathullah Appa College, Tirunelveli. She has completed M.Phil. (Computer Science) and M.Tech (Computer and Information Technology) in Manonmaniam Sundaranar University, Tirunelveli. She has involved in various academic activities. She has attended so many national and international seminars, conferences and presented numerous research papers. She is a member of ISTE and IEANG and her specialization is Image Mining.